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GB A 2045493 EP A1 0070449

(58) Field of search
G1A
G4N

(54) Detecting low level radiation sources

(57) A system for detecting a low level radiation source, for use with or as a security system, has a free standing self-sufficient component disposed at or near a high risk area to be protected, and a remote monitoring unit 24. A detector assembly 16, 18 is provided which measures dynamically the ambient or background average radiation level B. If a radiation level is sensed which is higher than said ambient level by a certain threshold level which is related to the standard deviation S of said ambient radiation an alarm signal is generated which activates audible or visual annunciators 14, 26. A self-testing facility 46, 48, 50 is also provided.

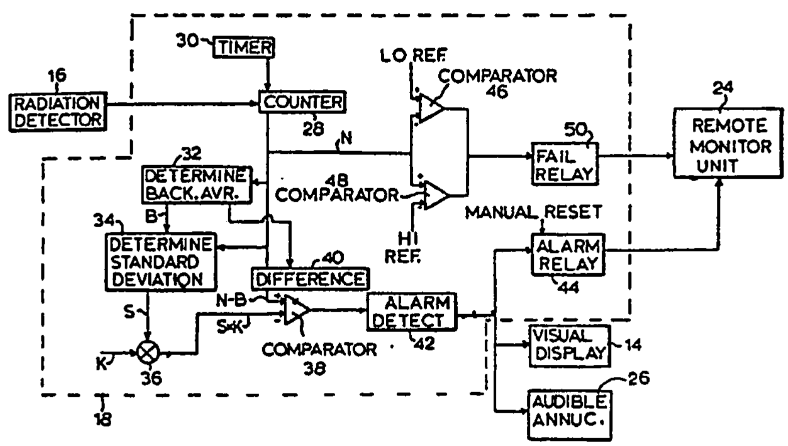

FIG.2

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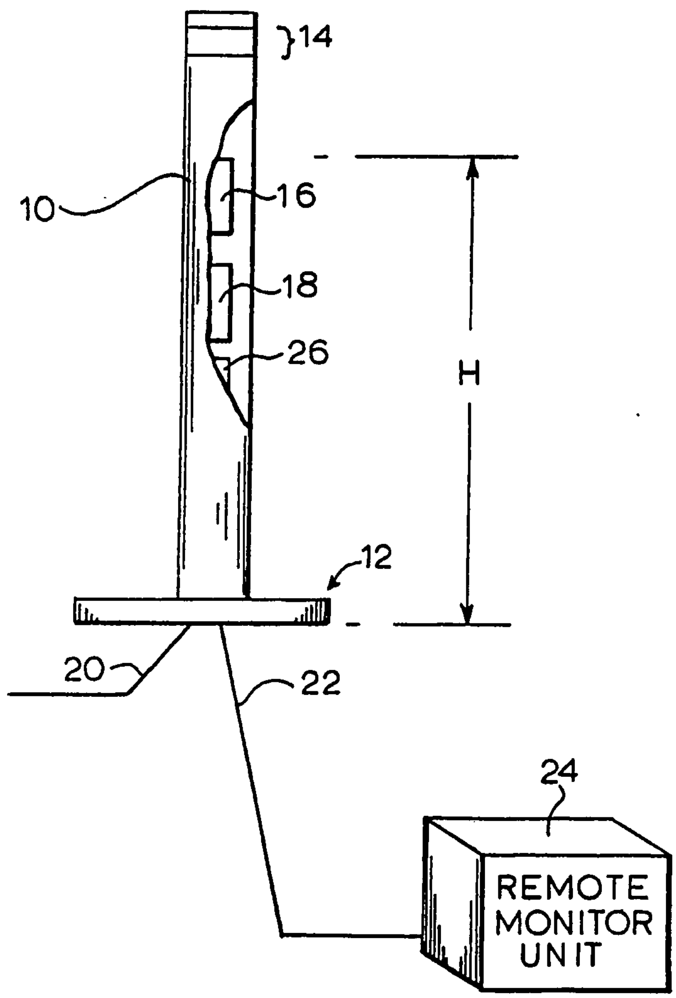

FIG.1

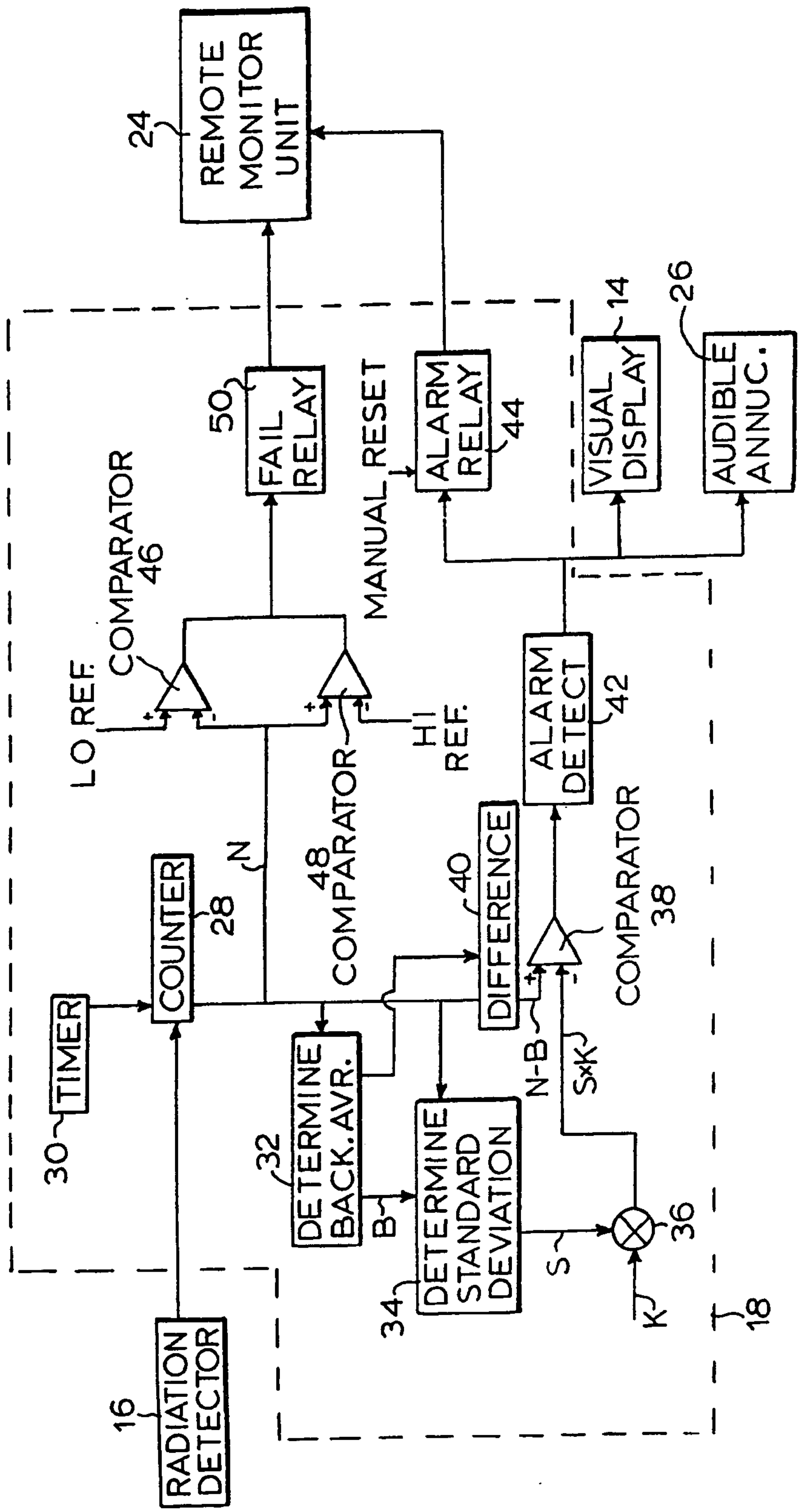
REMOTE MONITOR UNIT
24
FAIL RELAY
50
ALARM RELAY
44
MANUAL RESET
VISUAL DISPLAY
14
AUDIBLE ANNUC.
26
COMPARATOR
46
LO REF.
HI REF.
COMPARATOR
48
COUNTER
28
TIMER
30
N
DIFFERENCE
40
ALARM DETECT
42
COMPARATOR
38
N-B
S×K
DETERMINE BACK. AVR.
32
B
DETERMINE STANDARD DEVIATION
34
S
K
36
18
RADIATION DETECTOR
16

FIG.2

SPECIFICATION

Method and system for detecting low level radiation sources

BACKGROUND OF THE INVENTION

1. Field of invention

This invention pertains to a system of detecting low level radiation sources within a preselected zone and for annunciating such a source. More particularly the invention is directed towards means for detecting the unauthorized movement of radioactive materials into or out of a protected area.

2. Background of the invention

Material with a relatively low radiation level have found numerous uses in different fields. For example, the use of such materials is widely spread in hospitals, universities and other governmental or private research centers. One of the undesirable side effects of the wide availability of radioactive materials is that these materials can be extremely dangerous and could be used for illegal purposes to the detriment of the health and welfare of the public as well as private entities, and it is impossible to insure absolute control over them.

The unauthorized transport of radioactive sources can be deterred by using detectors which must be very sensitive to be able to detect even small radiation levels in a very short period of time, i.e. before the source moves out of the range of the detector. At the same time the detectors must be immune to normal changes in the background radiation level. Furthermore the detectors must be self-sufficient and must blend in with almost any background. Finally the detectors must be substantially fail safe. Inherently, false operations are unacceptable for the contemplated application.

Objectives and summary of the invention

In view of the above, an objective of the present invention is to provide a system of detecting sources of relatively low radiation level fast but unobtrusively.

Another objective is to provide a system which is self-contained so that it can be operated with virtually no supervision.

A further objective is to provide a system capable of performing its function without interrupting everyday activities.

An additional objective is to provide a system which can be integrated with an existing security system.

Other objectives and advantages shall become apparent in the following description of the invention.

According to this invention a system for detecting a low-level radiation source comprises a detector assembly having a radiation detector which generates signals corresponding to the instantaneous radiation level around the assembly, signal processing means for analyzing said signals to determine when an alarm condition occurs, and indication assembly for visual and audio communication of the occurence of said alarm condition. The assembly is housed in a vertical stanchion with a featureless exterior. The system further comprises a remote assembly operatively connected to said detector assembly for indicating the occurence of an alarm condition as well as a system failure. Alternatively since the detector assembly is equipped with standard relay contacts, it could be monitored by an existing security system.

The system is adapted to perform sequential measurements of the instantaneous radiation level around the detector assembly. The results of these measurements are fed to the signal processor which determines dynamically a running average level for said radiation and a corresponding standard deviation. Thus when the detector assembly is disposed at a particular location for a period of time, the system establishes a normal running average value and standard deviation for the background or ambient radiation characteristic of that particular location. Moreover the average value and the standard deviation are continuously updated to compensate automatically for natural variations in said background radiation due to solar flares or other factors. Normally these variations have a relatively low rate of change. If the standard deviation exceeds certain preselected limits an alarm condition is assumed and an appropriate signal is sent to the indication assembly. The system is also adapted to conduct self-tests by monitoring the above-mentioned instantaneous measurements and generating a fail signal when said measurements are outside a preselected range.

Brief description of the drawings

Figure 1 shows a partial sectional view of the housing and the detector assembly contained therein, constructed in accordance with the invention; and

Figure 2 shows a schematic diagram of the system.

Detailed description of the invention

Referring now to Figure 1, the main component of the system comprises a vertical stanchion 10 resting on a base 12. The stanchion is terminated at its upper extremity by a visual display unit 14 provided with a green light for indicating a "clear" and a red light for indicating an "alarm" condition to security personnel in the area. Inside the stanchion there is a detector assembly comprising a radiation detector 16 and an electronic package 18. Preferably radiation detector 16 is positioned and arranged at a predetermined height H from the

floor as shown. Height H is selected to insure that the radiation counter is in an optimal position to detect a low source of radiation surreptitiously carried by a person who walks by the stanchion. It has been found that optimally H should be midway between the shoulder and the knees of an average person, or about 38 inches (about 97 cms).

Two sets of cables 20 and 22 are connected to the stanchion. Cable 20 provides power to the radiation detector assembly while cable 22 provides multiple connections to a remote unit 24 which monitors the operation of the radiation detector assembly.

Except for the power cable 20, the assembly housed in stanchion 10 is completely self-sufficient. It monitors the radiation level of the area surrounding it and when an abnormal level is detected, and it indicates either a "clear" condition (green light) or an "alarm" condition (red light) on visual display 14. Optionally or alternatively, an "alarm" condition is also indicated by activating an audible annunciator 26 such as a chime also disposed within the stanchion.

The stanchion is placed at a location within a high risk area (such as near a bank vault) in a manner so that it can be seen by security personnel. When a person carrying an object which incorporates a radiation source passes by the stanchion, the stanchion activates its visual display and/or audio annunciator as described above. The detected object could be a dangerous radioactive material or alternatively it could comprise high security items such as documents, electronic parts etc. which have been marked with an appropriate radioactive means. In the first instance, the purpose of the present system is to prevent a person from moving an unauthorized and dangerous object into a high risk area. In the second instance the system is provided to prevent the unauthorized removal of certain objects from a high security area.

The remote monitor unit 24 may be placed at any convenient location, such as for example, a security station. In addition to duplicating the function of the visual display unit 14, the remote unit also provides additional information regarding the status of the radiation detector assembly. Alternatively, as shall be described below, the radiation assembly may be easily interfaced with an existing burgular alarm or other theft-oriented security system.

The components of the radiation detector assembly are shown in Figure 2. Radiation detector 16 measures the instantaneous radiation around it and generates pulses. The rate of these pulses is proportional to the intensity of the radiation. These pulses are fed into a radiation counter 28 of electonic package 18. Counter 28 is enabled by timer 30 for consecutive time intervals, each time interval having a constant preselected duration. At the end of each time interval the counter 30 is reset. The sequential radiation counter appearing at the output of counter 28 are used by a circuit 32 to determine the average as background or ambient radiation level characteristic of the particular location of the detector assembly. This average level may be determined in a number of ways. For example, a running average level may be determined by using the formula

$$B_i = \frac{N_i + mB_{i-1}}{m+1}$$

Where B_1 is the average background radiation level after the i-th count, N_i is the i-th count as determined by counter 28 and m is a preselected constant.

The output of circuits 28 and 32 are used by circuit 34 to determine the standard deviation of m counts. In general the standard deviation S_i after i intervals is given by:

$$S_i = \sqrt{\frac{B}{\sqrt{(2m-1)}}}$$

The standard S_i deviation determined by circuit 34 is multiplied by a constant K in multiplier 36 and the product is used as a threshold and fed to the inverting input of a first comparator 38. The output of counter 28 is also fed into a difference circuit 40 adapted to determine the difference between the average background radiation level B as determined by circuit 32 and the latest count N in counter 28. This difference (i.e. N-B) is fed as a second or non-inverting input to comparator 38. Comparator 38 is adapted to generate an output when the difference signal from circuit 40 is greater than the output of multiplier 36. The comparator output is fed to an alarm detector 42 adapted to generate an alarm signal in accordance to a preselected criteria. For example the alarm circuit may generate an alarm signal if L consecutive counts exceed the output of multiplier 36 as determined by comparator 38. Preferably these counts are excluded from the average background radiation level B and the corresponding standard deviation S.

The alarm signal is fed to display unit 14 and audible annunciator 26. Furthermore the alarm signal is also fed to an alarm relay. This relay 44 is used as a means for indicating the condition of the detector assembly 18 to remote monitor unit 24. Preferably alarm relay 44 should be provided with a manual reset means.

In order to monitor the performance of the radiation detector 16 and counter 28, the radiation counter output N is also fed to two comparator 46, and 48 as shown. These comparators are adapted to compare the counter output respectively to a high reference level and a low reference level. If the counter output is outside the range between said HIGH and LOW reference levels, a fail signal is generated by the comparators

and used to energize a fail relay 50. The output fo the fail relay is also connected to remote monitor unit 24 as shown. The circuits which make up the electronic package 18 can be implemented by using discrete well-known analog or digital circuits. Alternatively one skilled in the art may also use a microprocessor to simulate the function of these circuits.

It is important to note that the system determines dynamically the average background radiation level and the standard deviation of the radiation which is characteristic of each particular location in which the detector assembly is paced. Therefore no field calibrations are necessary. Furthermore these parameters are also automatically adjusted for changing radiation levels. For example background radiaion level changes due to natural phenomena such as a sun flares cause corresponding changes in said parameters. Similarly, appropriate adjustments are made in these parameters when the spacing between the stanchion and structural walls or other objects is changed or if some stationary objects are shifted.

The three important factors which determine the performance of the present system are: its reaction time (i.e. how long must a radiation source be in the stanchion's vicinity before it its detected), its sensitivity (i.e. the minimum level of radiation detected) and its reliability (i.e. the frequency of false alarms). These factors are dependent on the various operational constant mentioned in the above description. It has been found that the system operates satisfactorily with the following operational constants.

Duration of each radiation count as determined by timer 30 N_i = 1.0 seconds
m = 20;
K = 4.5;
L (number of consecutive counts above the threshold KS) = 2
HIGH REF = 1 mR/hr;
LOW REF = 0

If a radiation detector comprising a 2" × 2"* plastic scintillator or a 2" × 2"* sodium iodide scintillator coupled to a photomultiplier (such as those manufactured by Bicron, Nuclear Enterprises, Hamamatsu or Ludlum) is used which produces 10^6 counts per minute for a radiation source of 1 mR/hr it is estimated that with the above defined operational constants a radiation source of 15 microcuries for the plastic scintillator or 10 microcuries for sodium iodide scintillator at 1MeV disposed 1 meter away can be detected by the system. Furthermore statistical calculations have shown that no more than one false alarm operation is to be expected per year.

Obviously numerous modifications could be made to the invention without departing from its scope as defind in the appended claims. For example the alarm relay 44 could also be used to control certain other devices 52 such as a camera oriented to take a picture of the surveilled area.

Alternatively, the same relay could be used to control to access to or from a restricted area by operating an access door.

* approximately 5×5 cms.

CLAIMS

1. A system for detecting a low source of radiation comprising:
means for dynamically determining the average radiation level at a predetermined location;
means for determining the instantaneous radiation level at said location; and
means for generating an alarm signal when said instantaneous radiation level exceeds said average radiation level by a threshold value.

2. The system of claim 1 further comprising means for determining the standard deviation of said radiation wherein said threshold value is a multiple of said standard deviation.

3. The system of claim 1 further comprising a visual display unit activated by said alarm signal.

4. The system of claim 3 further comprising a self-sufficient housing which contains said visual display unit, said means for dynamically determining the average radiation level, said means for determing the instantaneous level and said generating means.

5. The system of claim 4 further comprising a remote unit adapted to monitor the status of the system.

6. A method of detecting a low source of radiation at a particular location comprising:
determining the background radiation level characteristic to said location;
detecting a higher radiation level which exceeds a threshold level dependent on said background level; and
generating an alarm signal in response to said higher radiation level.

7. The method of claim 6 wherein said background radiation level is determined dynamically by sensing sequentially the instantaneous radiation at said location and determining a running average value of said instantaneous radiation.

8. The method of claim 7 wherein said threshold level is dependent on said running average value.

9. The method of claim 8 further comprising determining a standard deviation corresponding to said running average value wherein said threshold level is a multiple of said standard deviation.

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